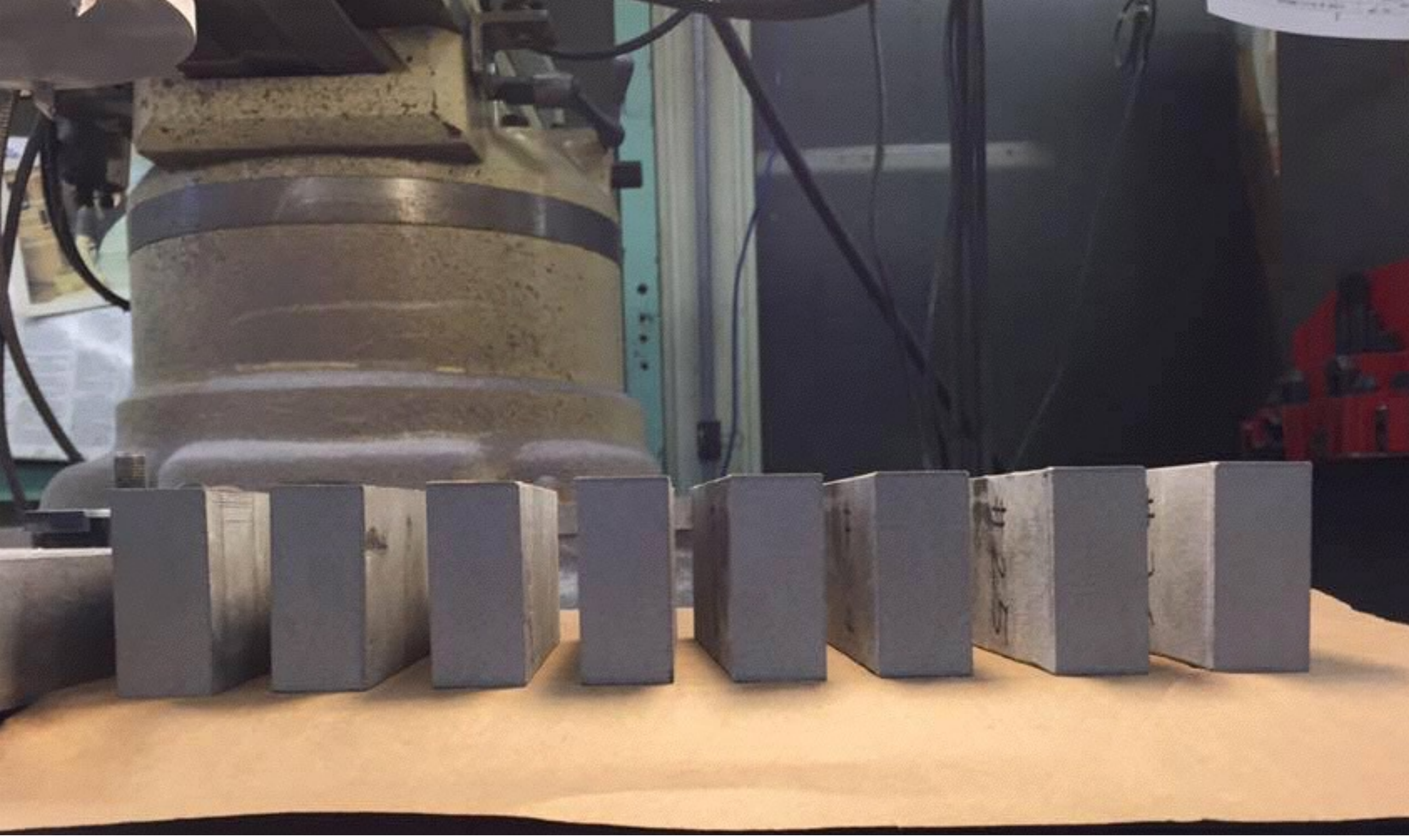


News from the EMCal

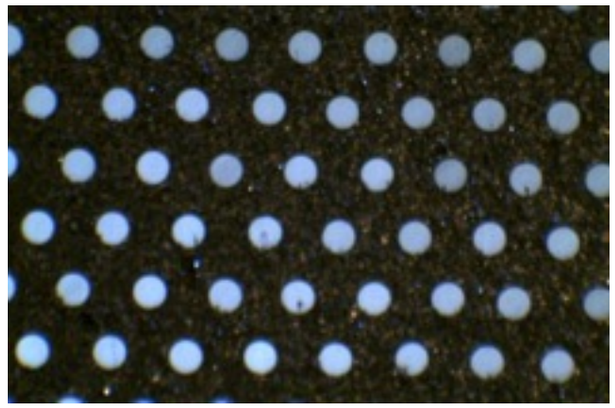
Anne Sickles for the EMCal Group

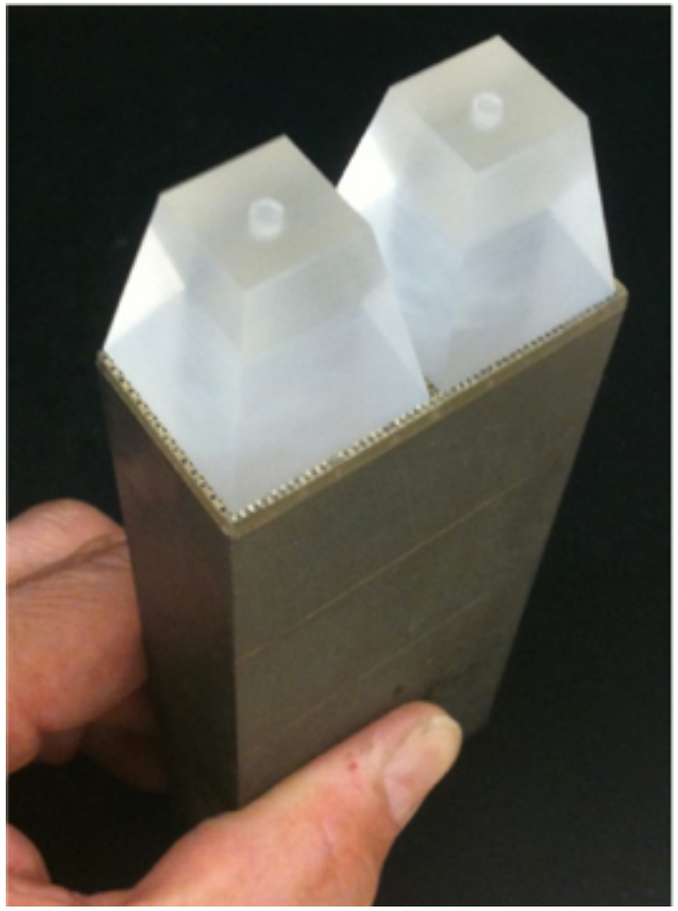
May 20, 2016

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

EMCal specs

- tungsten powder / scintillating fiber EMCal
  - 2.3 cm Moliere radius suitable for high multiplicity HI environment at a detector radius of 90cm
- $\Delta\eta x\Delta\phi = 0.024x0.024 = \sim 25k$ towers
  - $X_0 = 7mm$, $18X_0 = 12cm$ thick absorber
- provides the necessary $15\%/\sqrt{E}$ energy resolution
- makes good use of the radial space inside the magnet
  - between the tracking and the inner HCal
- designed developed at UCLA

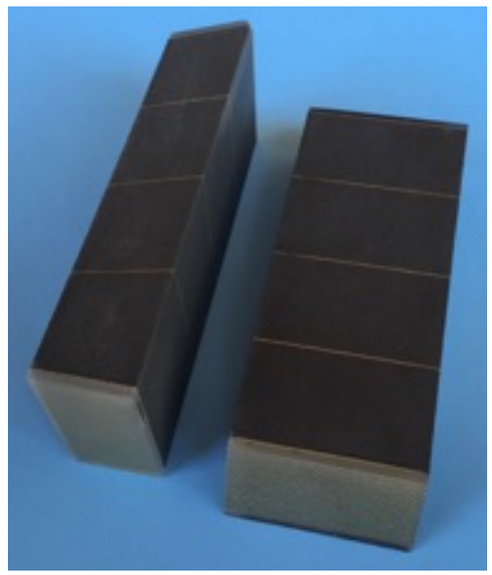




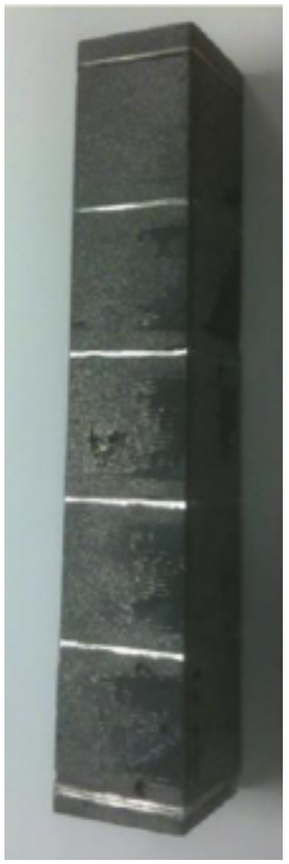
two towers

EMCal plan

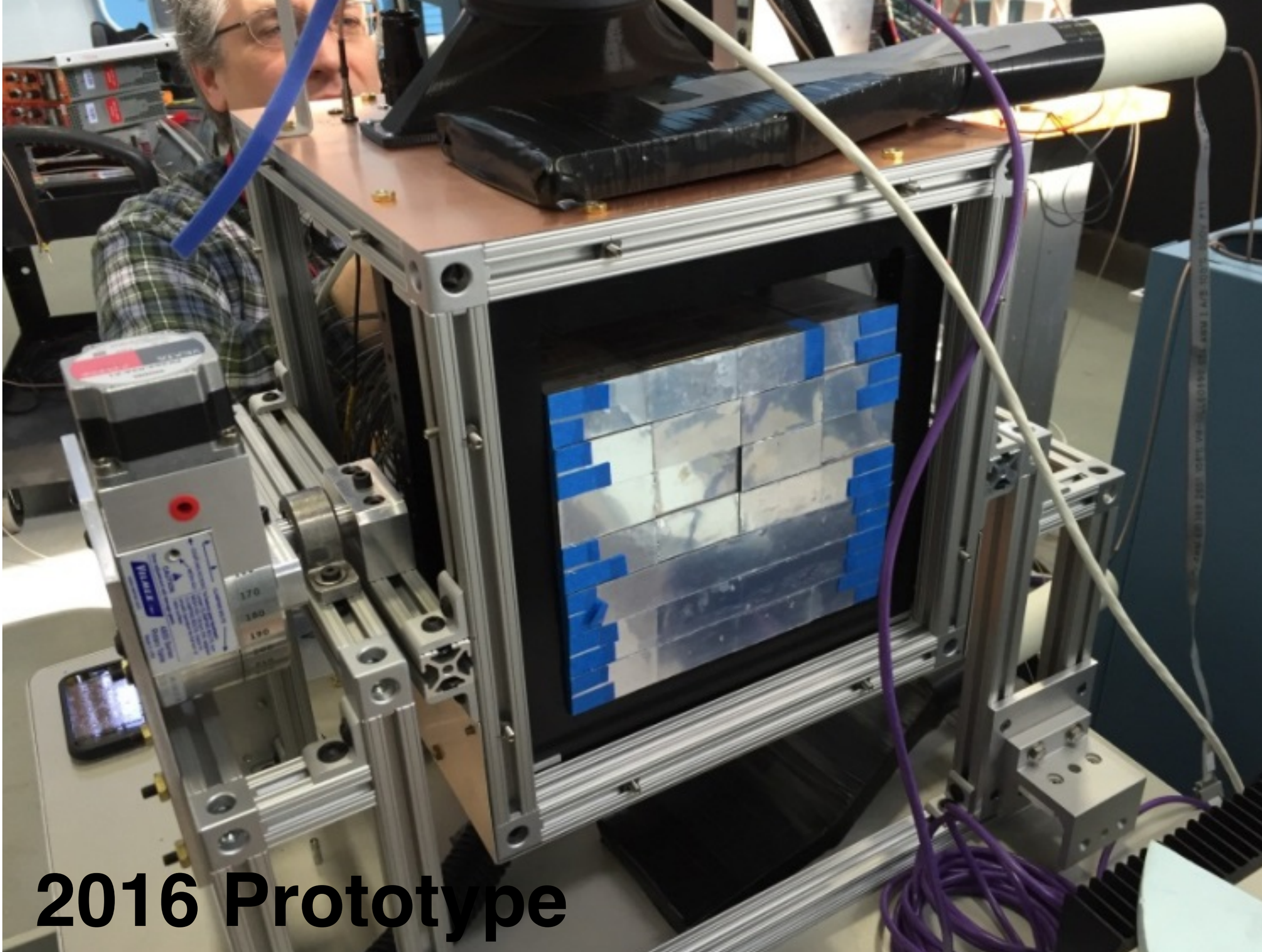
- projective in 2 demensions
  - fibers point back to the IP in ϕ & η
  - 1D projective production under control; 2D projective production process needs development
  - possible we'll only need ϕ projectivity



  - recent improvements to simulations improve e/h separation from initial studies
  - 2D will always have better performance, but production process still under development



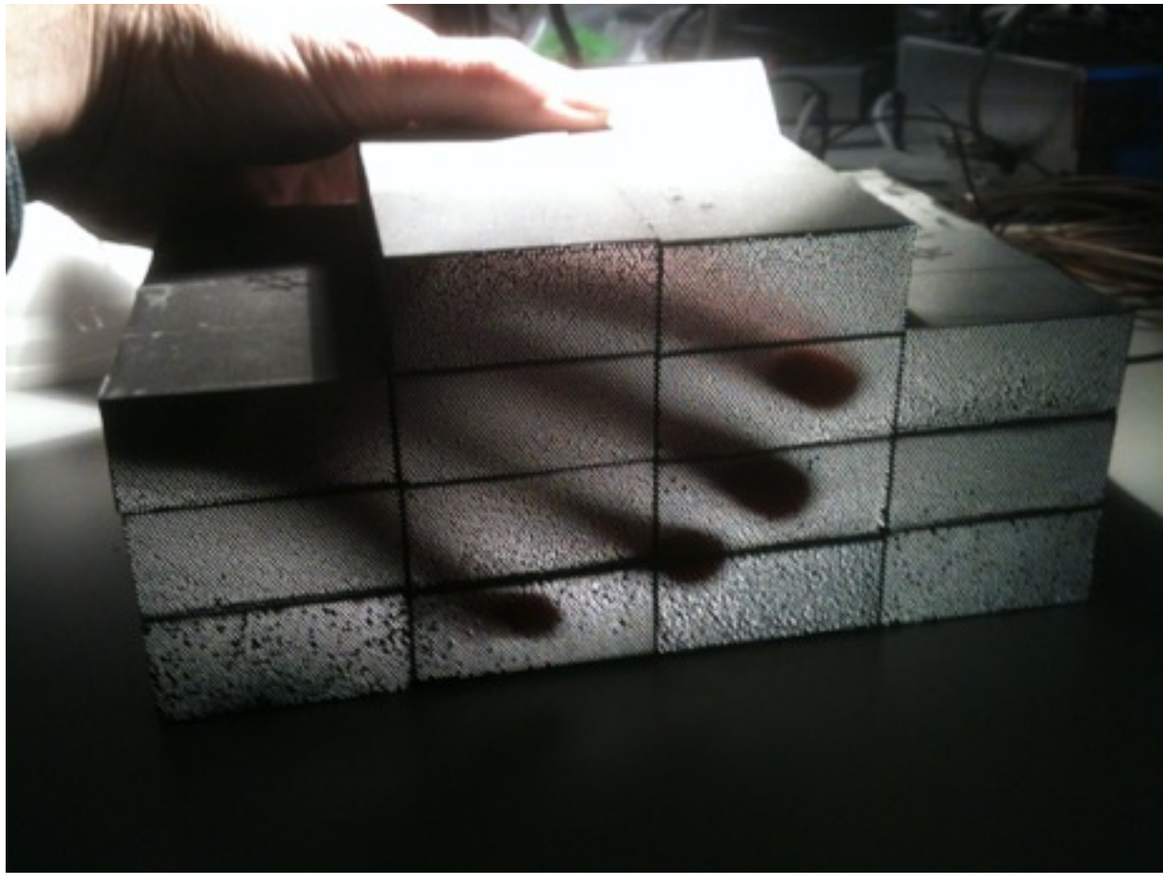
- **1D/2D projectivity is a major decision point in the EMCal design**

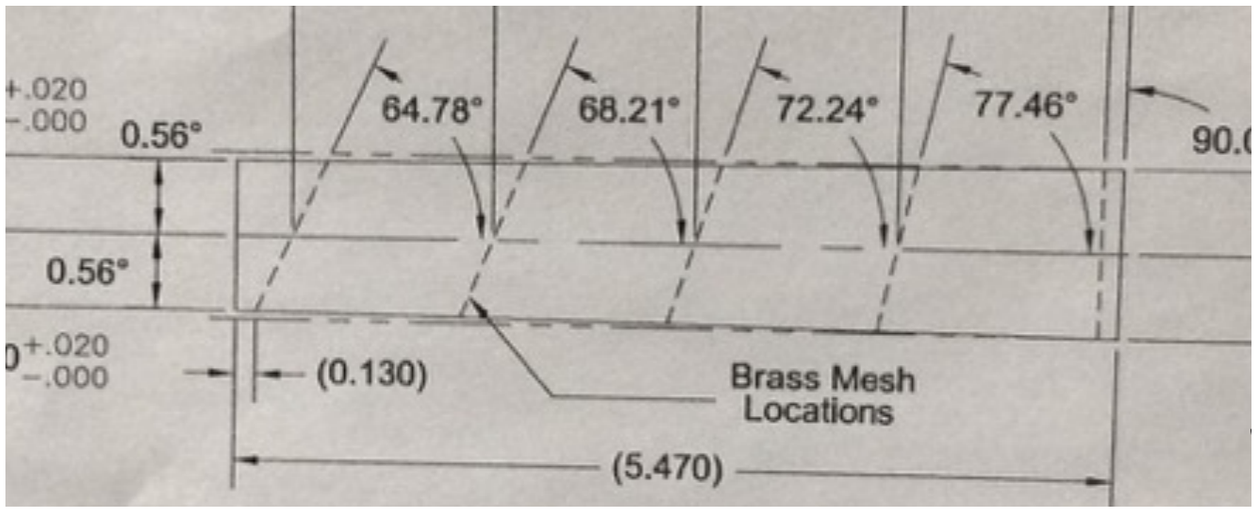


2016 Prototype

tested EMCal

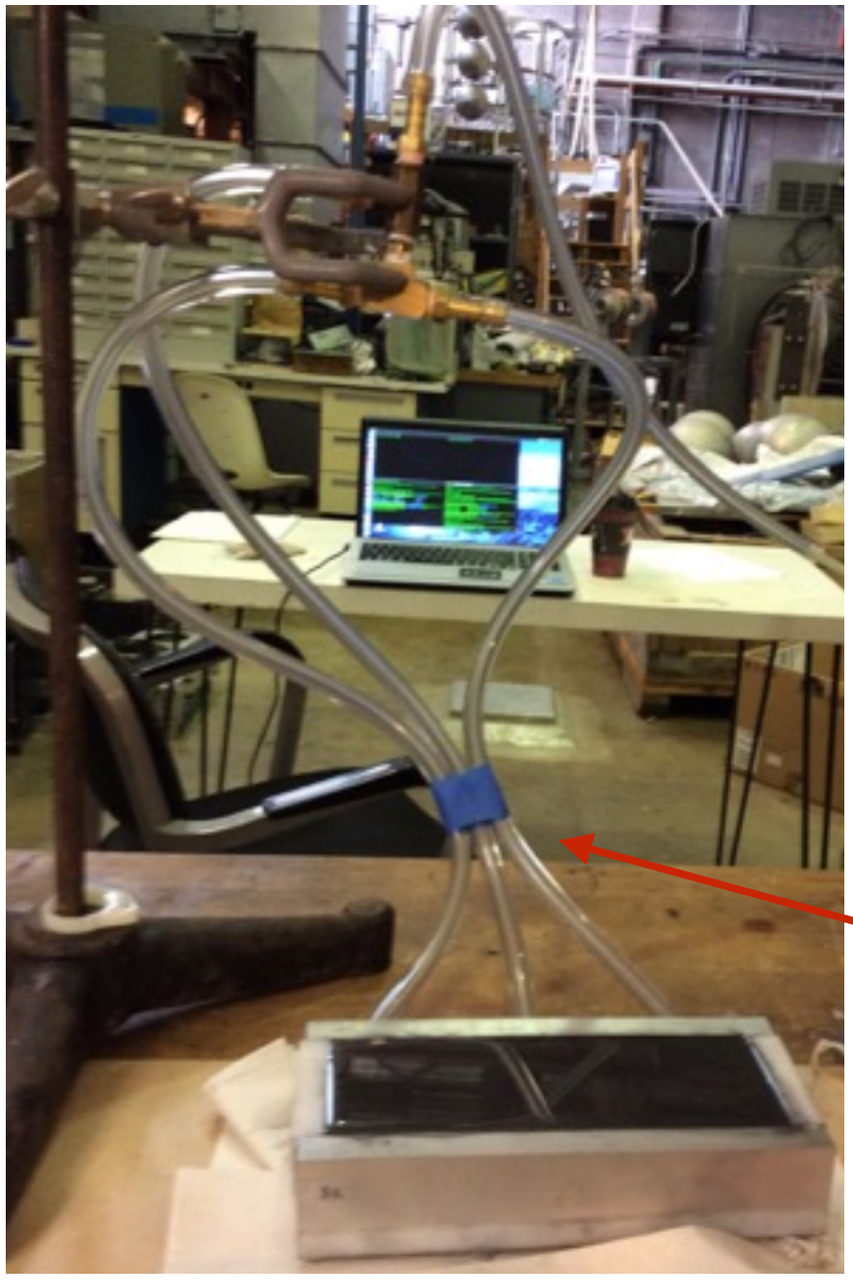
- 1D projective modules (in ϕ)
- blocks constructed to 1x2 towers
- first large scale building effort of these calorimeters within sPHENIX





production process @ Illinois

bathtub mold



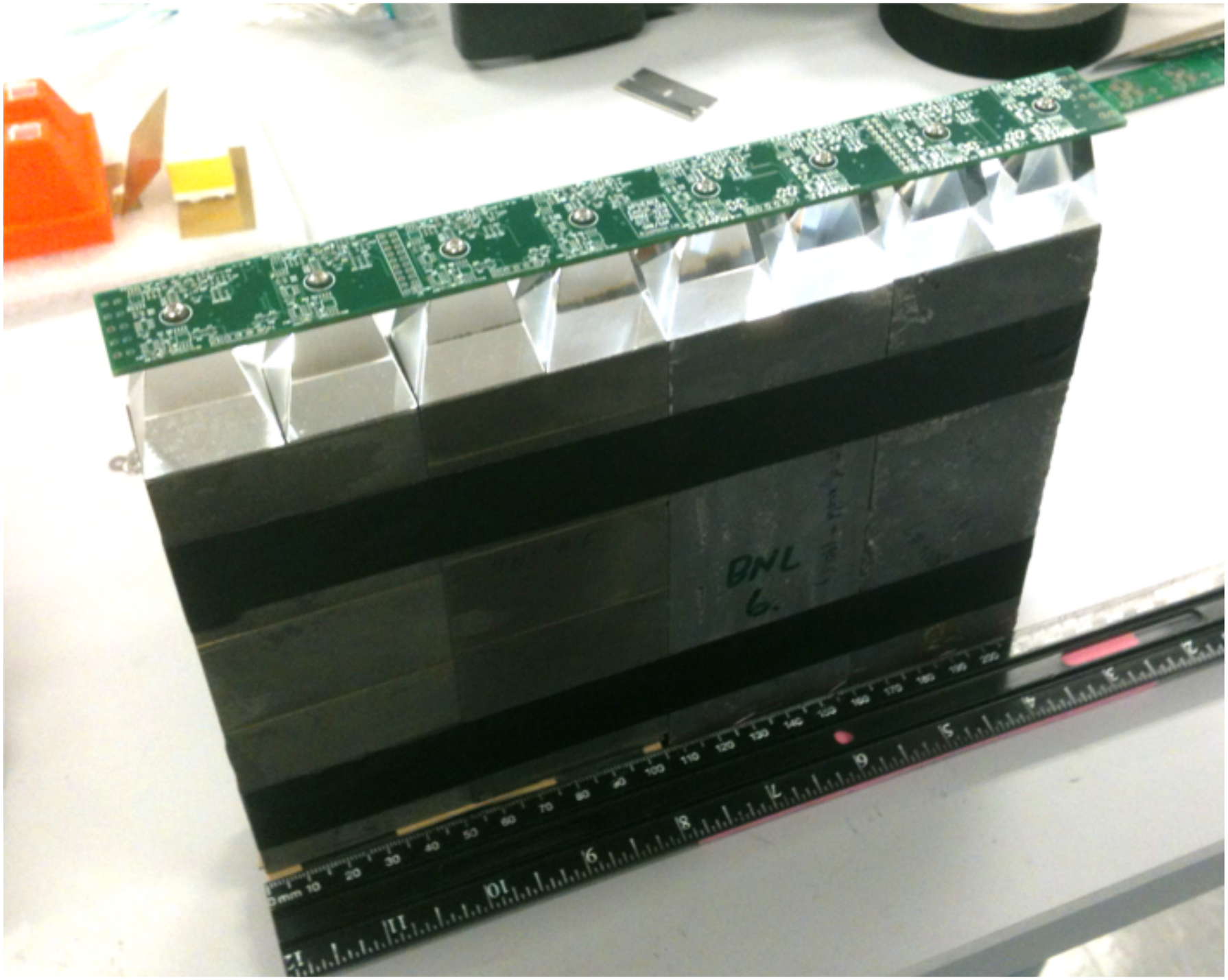
vacuum

before filling with tungsten & epoxy

3d printed mold bottom

V. Loggins, E. Thorsland

preamps & SiPMs

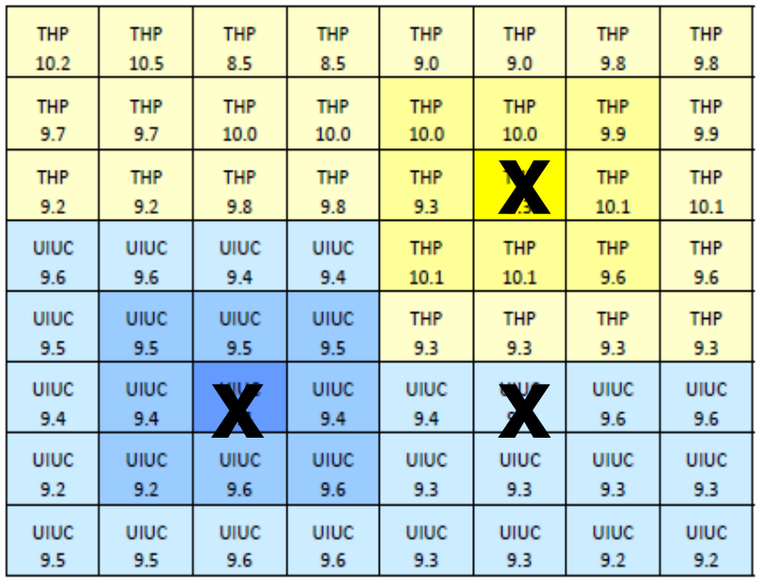


S. Stoll

prototype construction

- 64 towers: 1/2 from Illinois; 1/2 from Tungsten Heavy Powder
  - arranged such that we could test the modules separately from the two sources
  - arranged to maximize impact of the best modules
- took data with the beam centered in 3 locations to study the impact of module variation
- this will be crucial for developing QA criteria to implement in the 2017 prototype

THP 10.2	THP 10.5	THP 8.5	THP 8.5	THP 9.0	THP 9.0	THP 9.8	THP 9.8
THP 9.7	THP 9.7	THP 10.0	THP 10.0	THP 10.0	THP 10.0	THP 9.9	THP 9.9
THP 9.2	THP 9.2	THP 9.8	THP 9.8	THP 9.3	THP 9.3	THP 10.1	THP 10.1
UIUC 9.6	UIUC 9.6	UIUC 9.4	UIUC 9.4	THP 10.1	THP 10.1	THP 9.6	THP 9.6
UIUC 9.5	UIUC 9.5	UIUC 9.5	UIUC 9.5	THP 9.3	THP 9.3	THP 9.3	THP 9.3
UIUC 9.4	UIUC 9.4	UIUC 9.4	UIUC 9.4	UIUC 9.4	UIUC 9.4	UIUC 9.6	UIUC 9.6
UIUC 9.2	UIUC 9.2	UIUC 9.6	UIUC 9.6	UIUC 9.3	UIUC 9.3	UIUC 9.3	UIUC 9.3
UIUC 9.5	UIUC 9.5	UIUC 9.6	UIUC 9.6	UIUC 9.3	UIUC 9.3	UIUC 9.2	UIUC 9.2



module QA

- concerns: density, density variation, fiber clarity, fiber spacing
  - direct impact on performance
- THP modules had greater module to module variation
  - buried fibers, density variations, misalignments
  - some cleanup work performed at Illinois & BNL

THP: buried/missing fibers

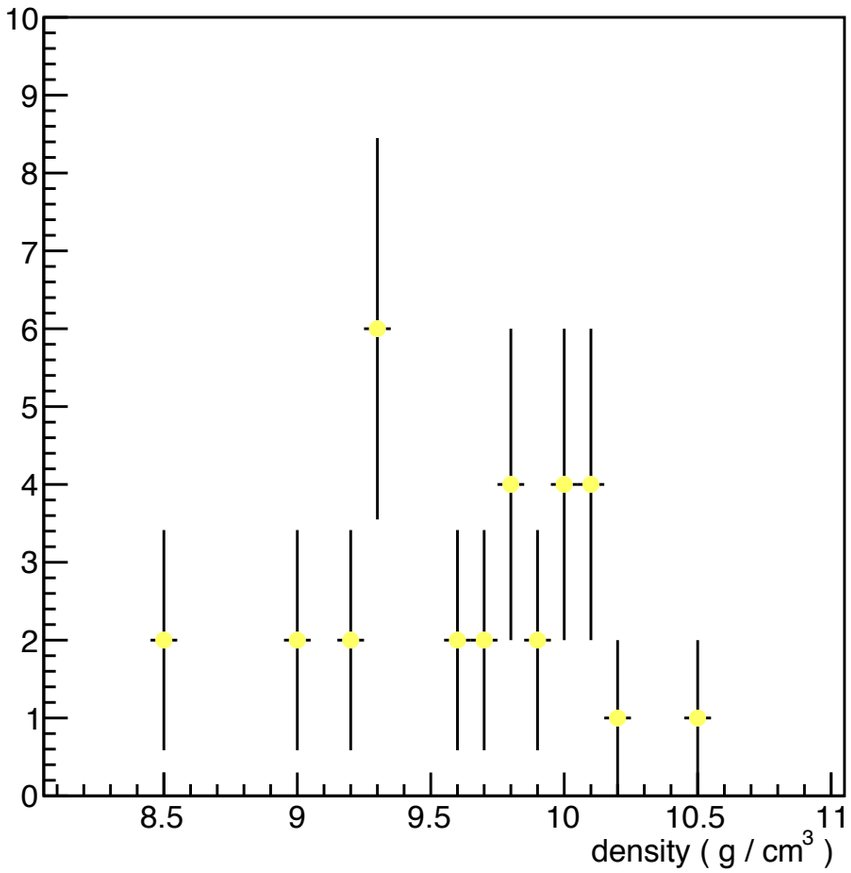
near the end of the Illinois production
very good fiber alignment on both ends of the module

module variations

THP modules

$\langle\rho\rangle = 9.6\ g/cm^3$

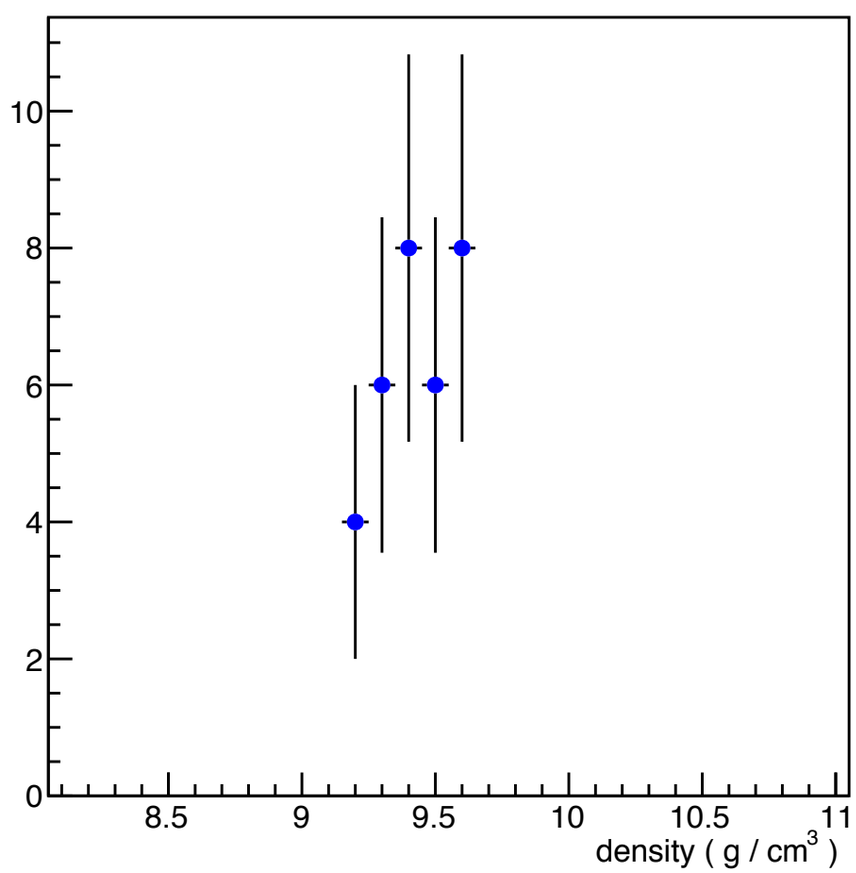
$RMS = 0.47\ g/cm^3$



Illinois modules

$\langle\rho\rangle = 9.4\ g/cm^3$

$RMS = 0.13\ g/cm^3$



- THP modules: 2% higher $\langle\rho\rangle$, 3x wider distribution than Illinois modules

testbeam

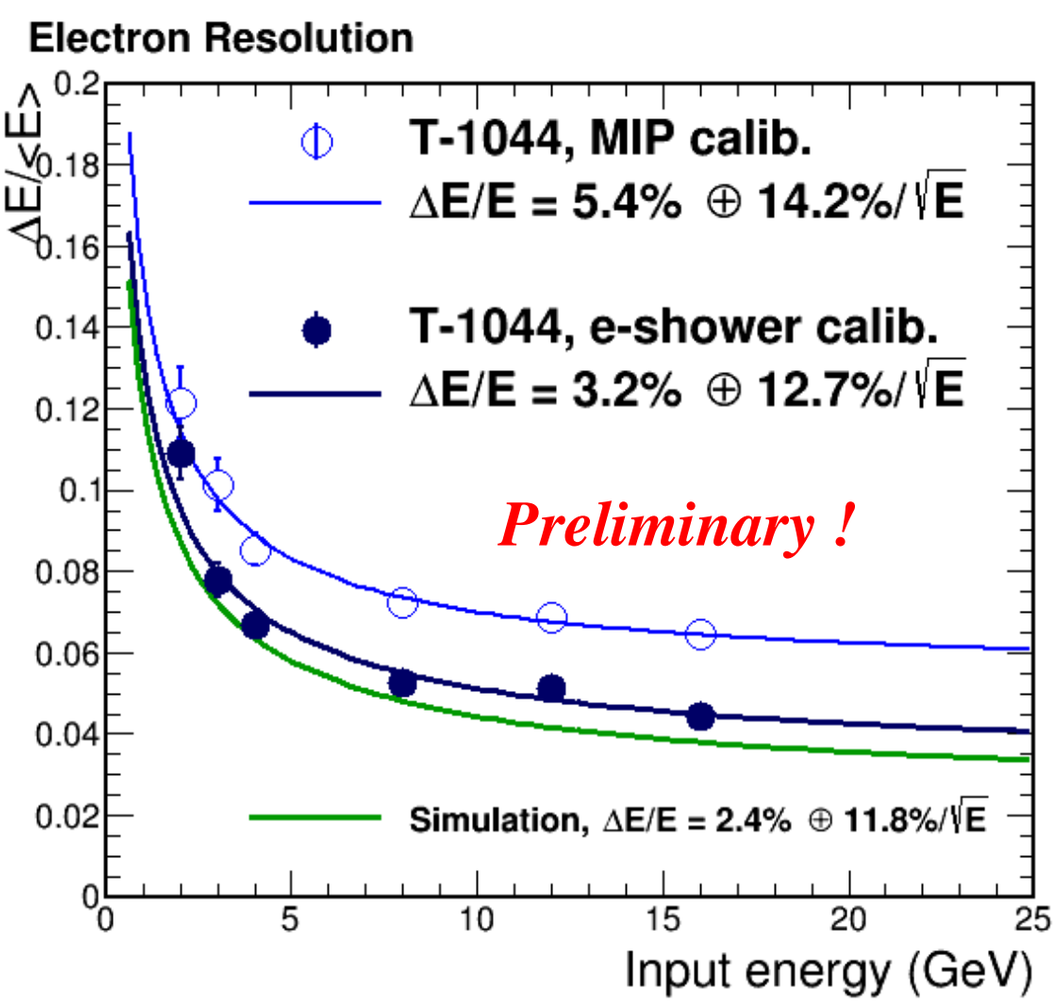
strong effort by many people!

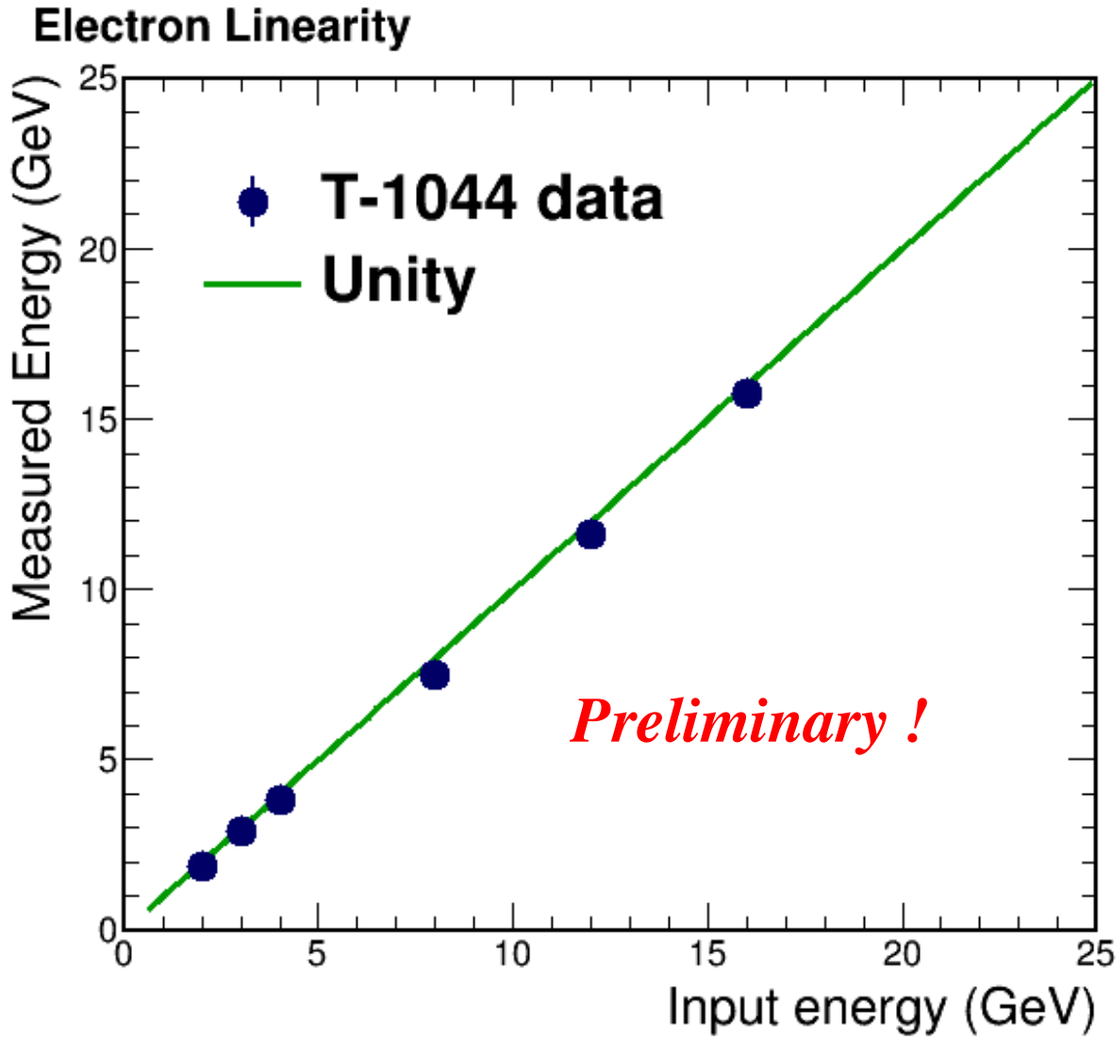
not all of whom shown here…. send me any good pictures you have!

first analysis

best of the Illinois modules
electron position selected by hodoscope
electrons selected via Cherenkov
no temperature variation correction

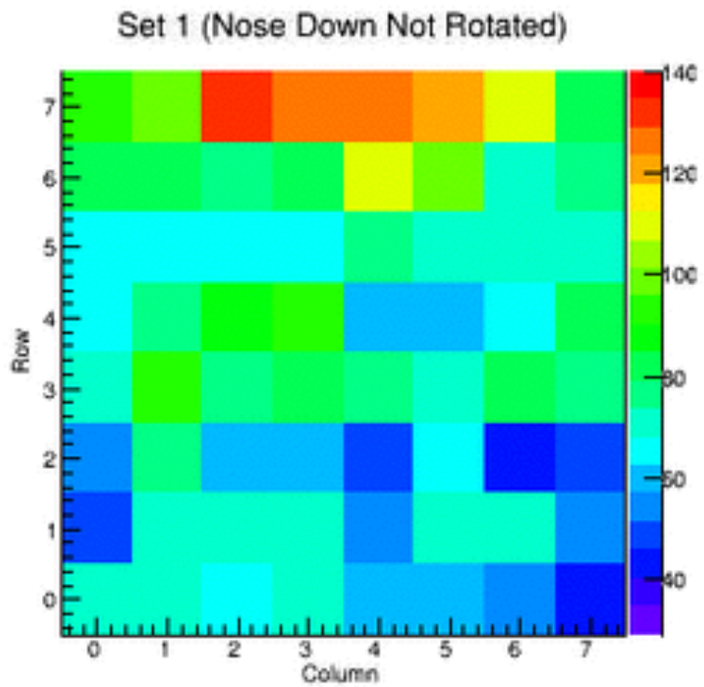
THP 10.2	THP 10.5	THP 8.5	THP 8.5	THP 9.0	THP 9.0	THP 9.8	THP 9.8
THP 9.7	THP 9.7	THP 10.0	THP 10.0	THP 10.0	THP 10.0	THP 9.9	THP 9.9
THP 9.2	THP 9.2	THP 9.8	THP 9.8	THP 9.3	THP 9.3	THP 10.1	THP 10.1
UIUC 9.6	UIUC 9.6	UIUC 9.4	UIUC 9.4	THP 10.1	THP 10.1	THP 9.6	THP 9.6
UIUC 9.5	UIUC 9.5	UIUC 9.5	UIUC 9.5	THP 9.3	THP 9.3	THP 9.3	THP 9.3
UIUC 9.4	UIUC 9.4	X	UIUC 9.4	UIUC 9.4	UIUC 9.4	UIUC 9.6	UIUC 9.6
UIUC 9.2	UIUC 9.2	UIUC 9.6	UIUC 9.6	UIUC 9.3	UIUC 9.3	UIUC 9.3	UIUC 9.3
UIUC 9.5	UIUC 9.5	UIUC 9.6	UIUC 9.6	UIUC 9.3	UIUC 9.3	UIUC 9.2	UIUC 9.2

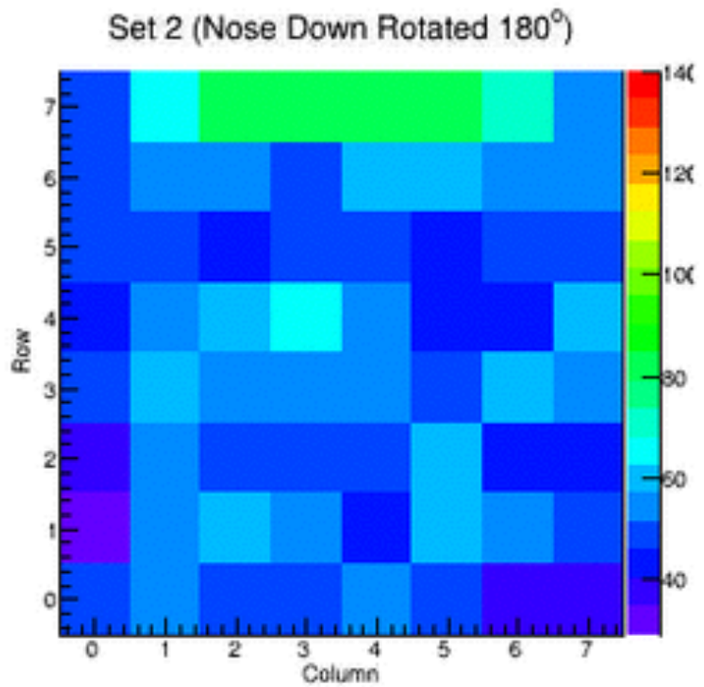


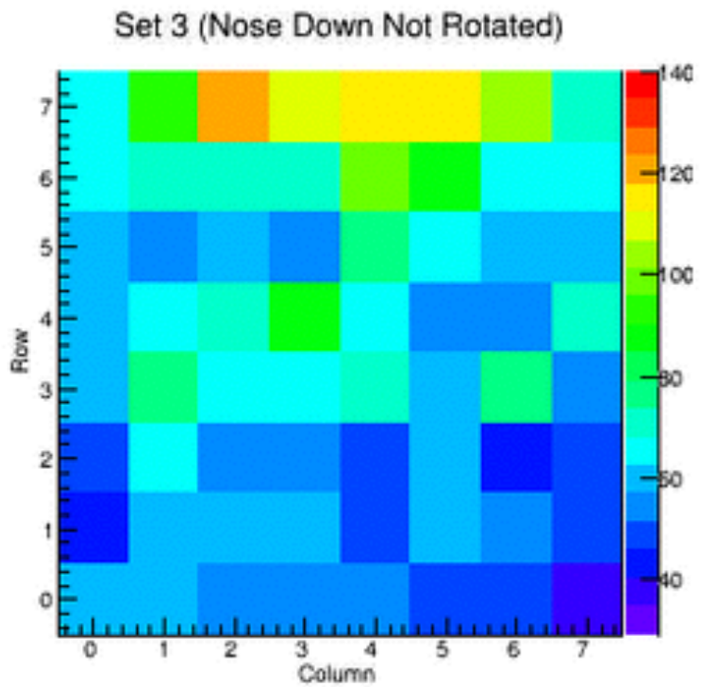


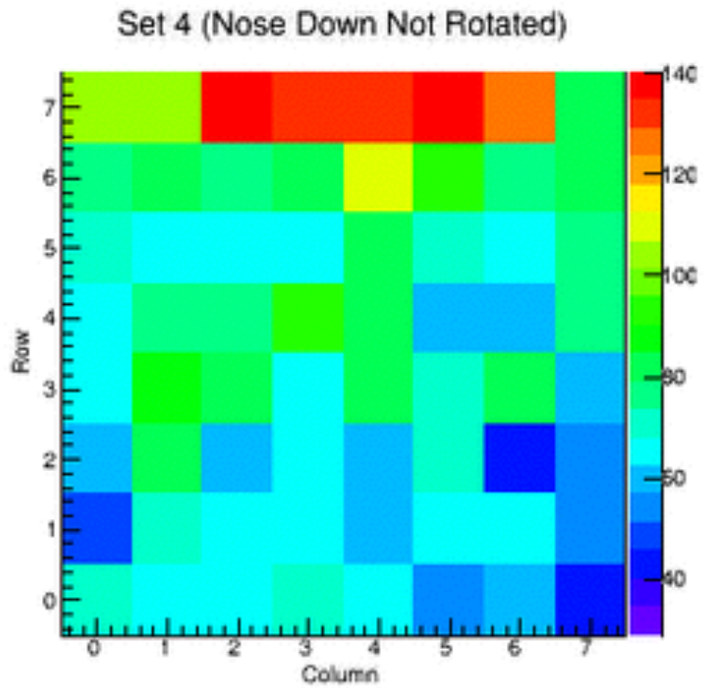
MIP peak positions

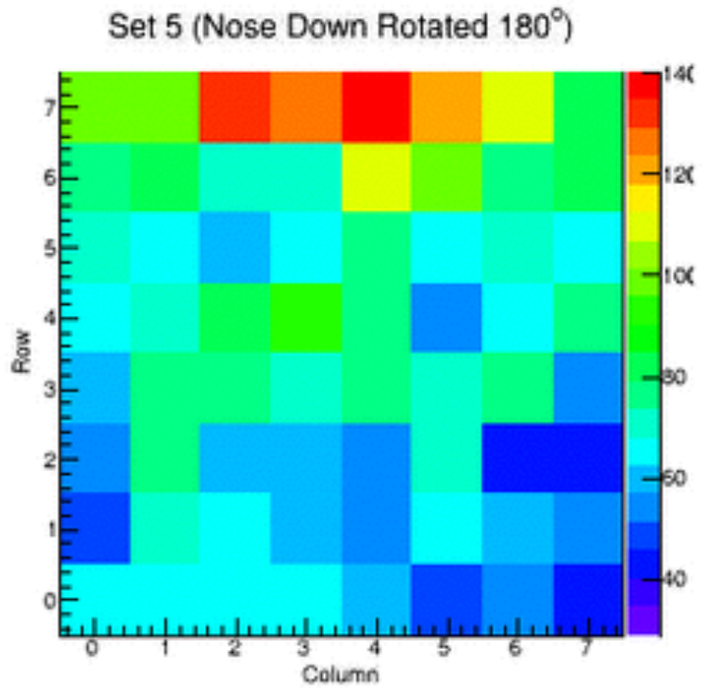
5 distinct sets of calibrations











unclear what is causing the variation set to set

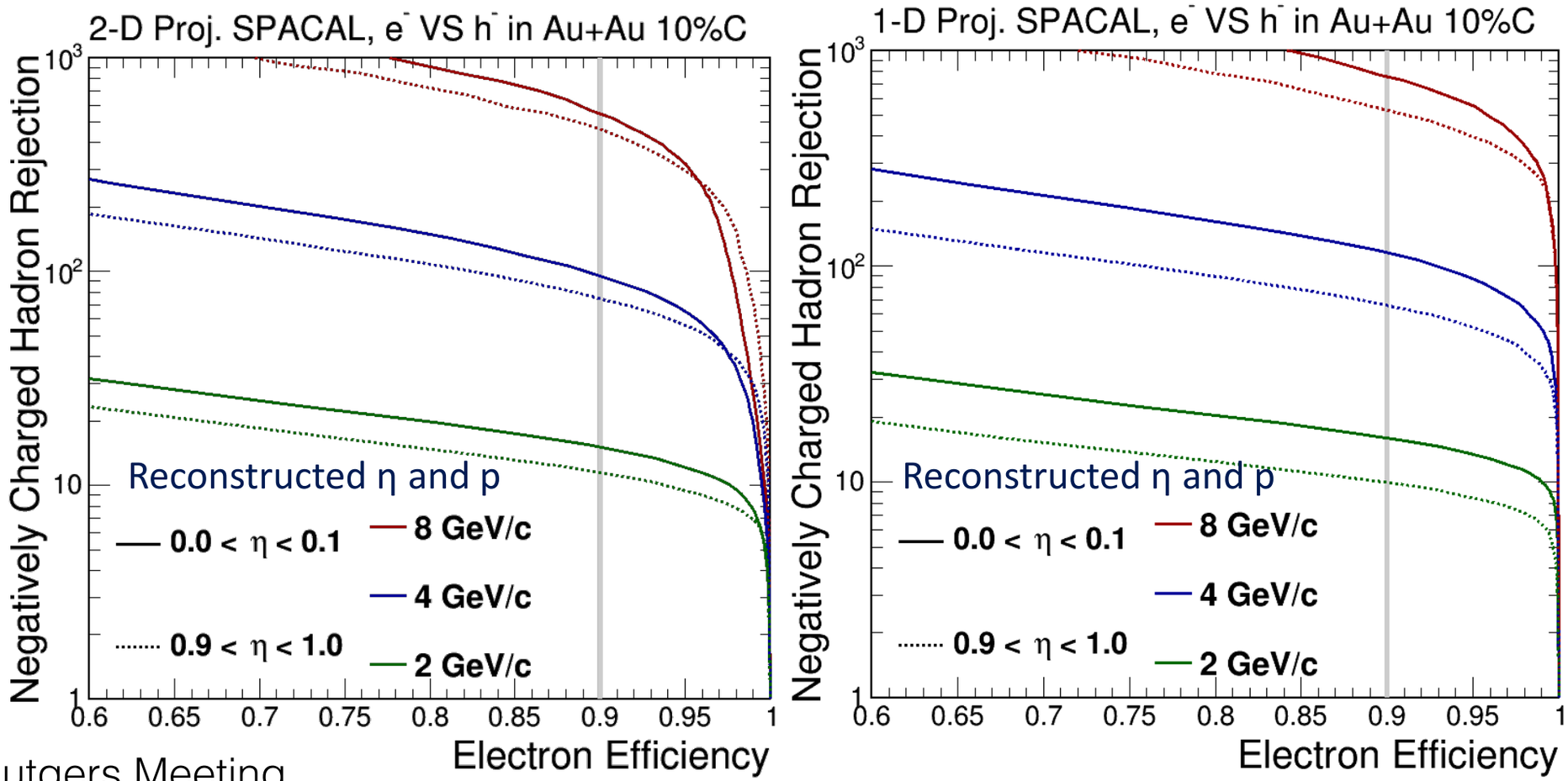
M. Skoby

ongoing work

- understand the MIP calibration
- measure module variation over the face of the calorimeter
- understand how module by module variations impact the performance
- comparison of hadron response to the simulations
- discussions in the simulations and EMCal meetings
- documentation in the wiki: https://wiki.bnl.gov/sPHENIX/index.php/T-1044

moving forward: 2D projectivity

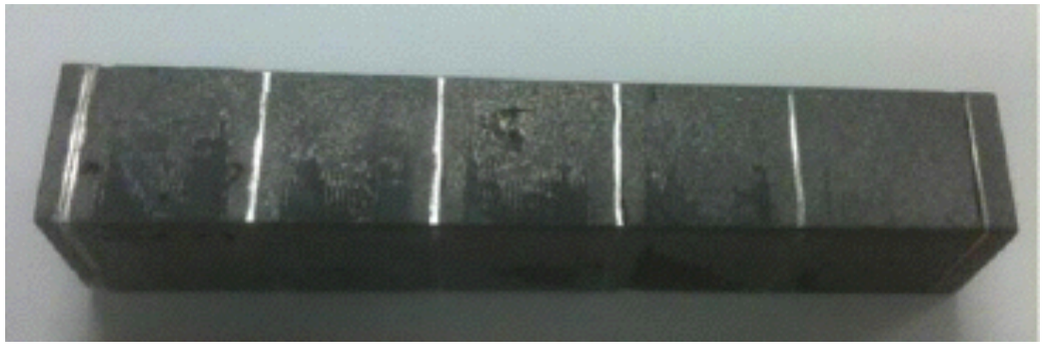
1D vs 2D projectivity



J. Huang, Rutgers Meeting

- 1D projective modules tested at FNAL testbeam last month
- projectivity in η improves large |η| hadron rejection
- 1/17 testbeam: deomonstrate high |η| performance

2D projectivity R&D plans



- 2D projective R&D at BNL, Illinois and THP (SBIR phase 1)
- single tower 2D projective modules have been built (0.024 x 0.024 segmentation)
- investigating building 2x2 blocks of 0.024 x 0.024 segmentation
- for reduced segmentation (0.03 x 0.03) its unclear whether building 2x2 would work or if it would be better to build the simpler, smaller 1x1 blocks

2x2 2D projective

- tapered meshes lead to offset holes, especially far from the center
  - 1x1 module construction worked, but 2x2 was thought to be impossible to fill with fibers

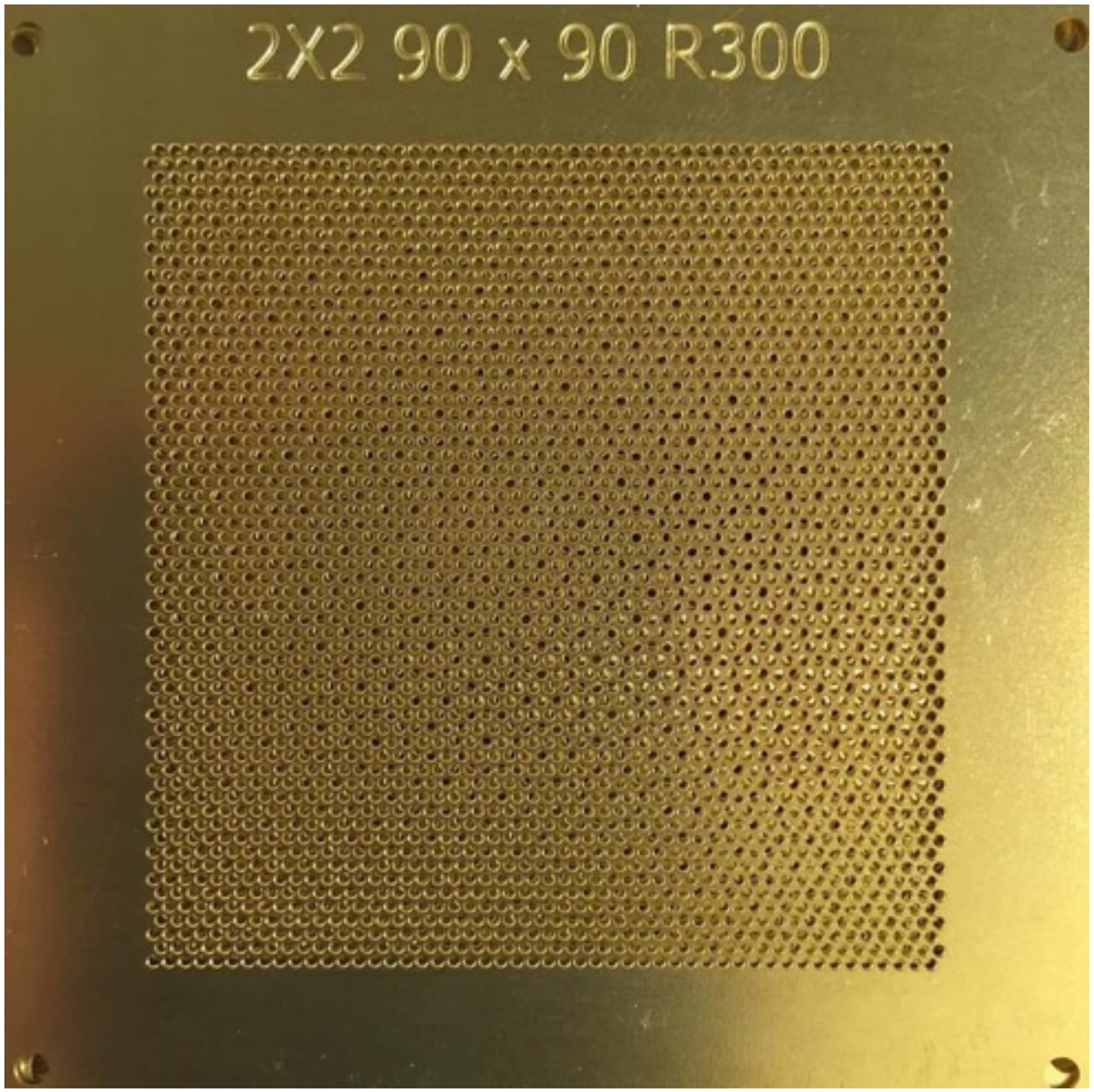
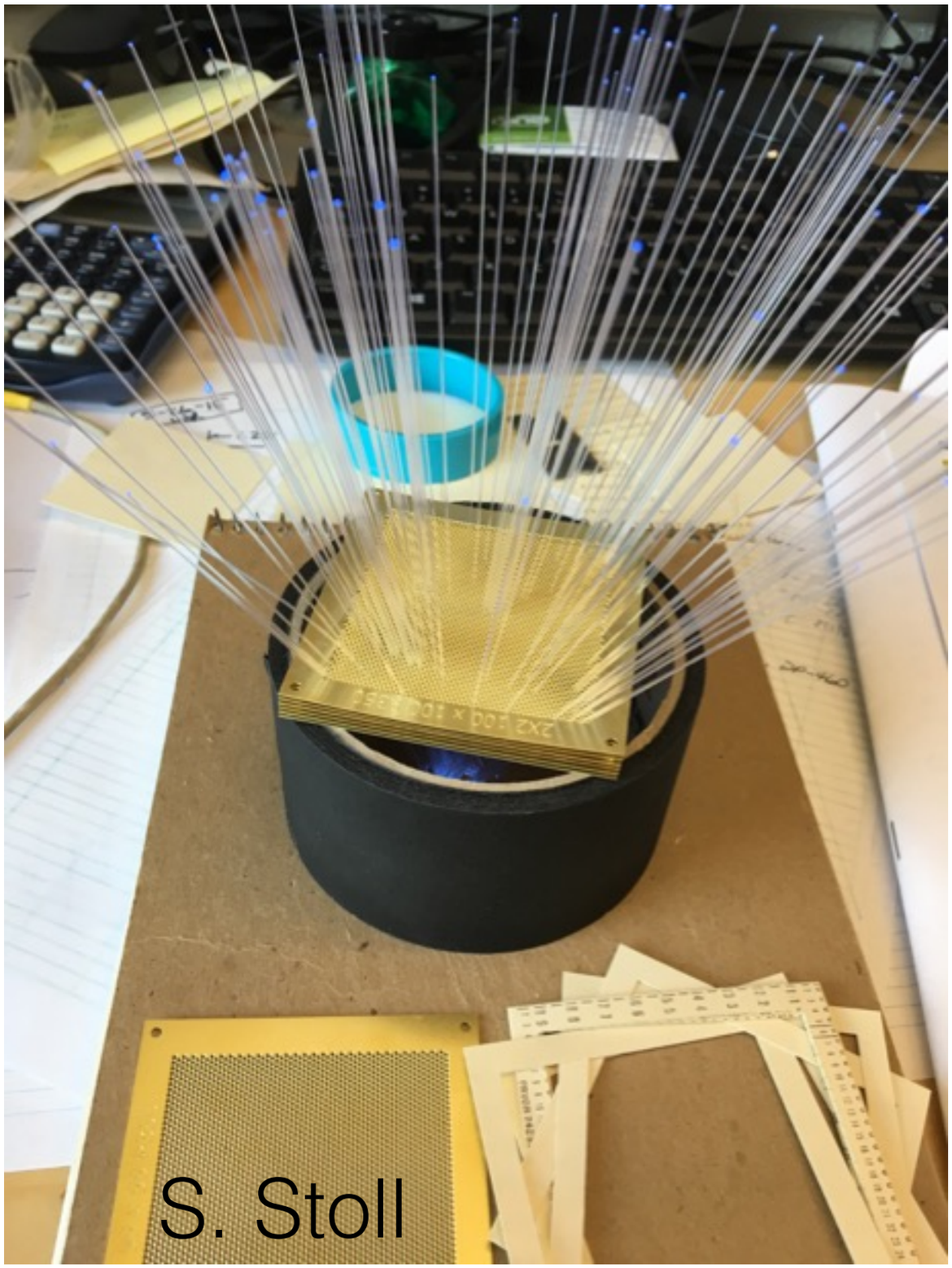


photo: P. Steinberg

2x2 2D projective

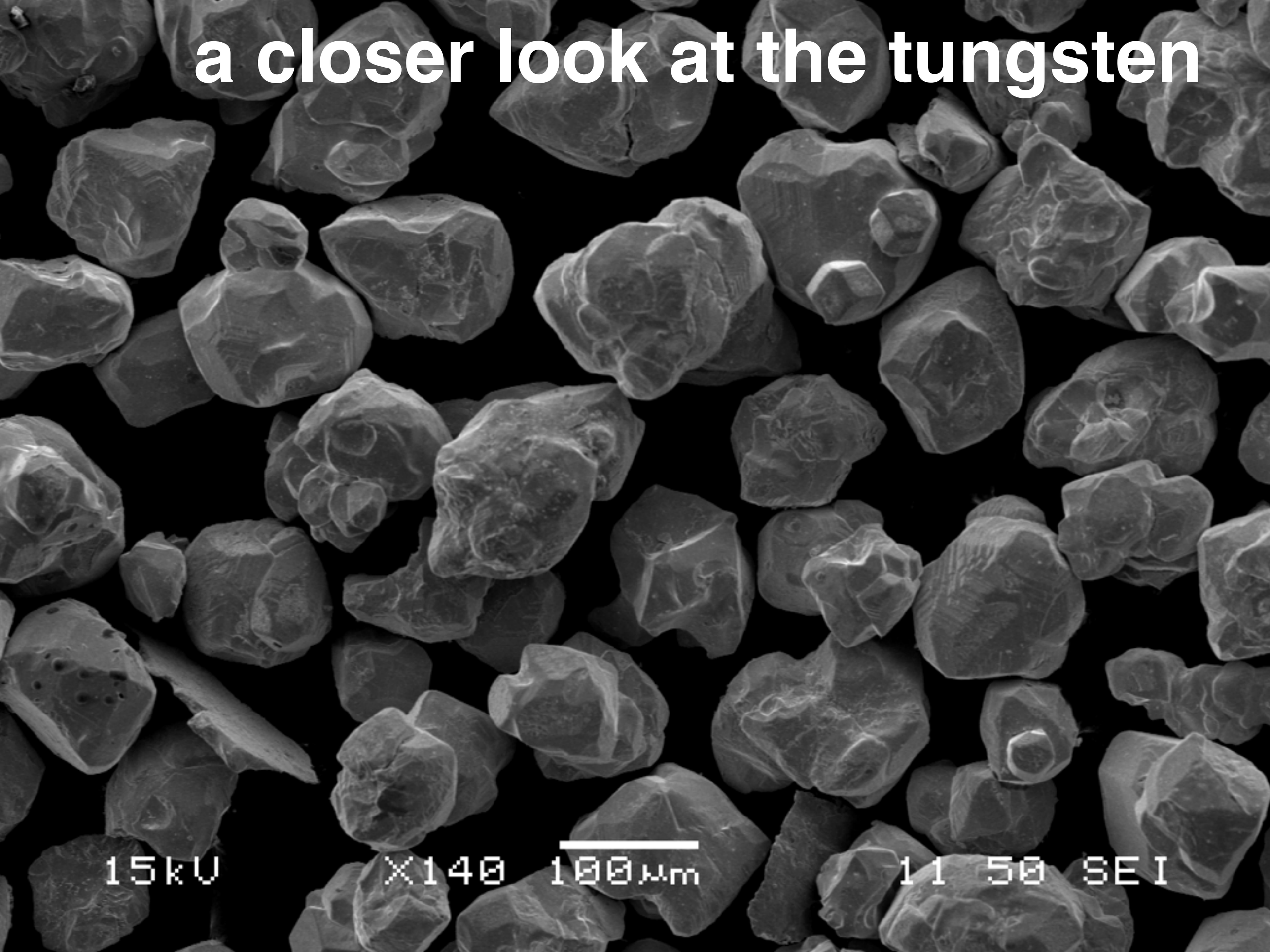
- Sean Stoll was able to successfully fill fibers in a variety of locations across the module by using simple shims



new EMCal segmentation

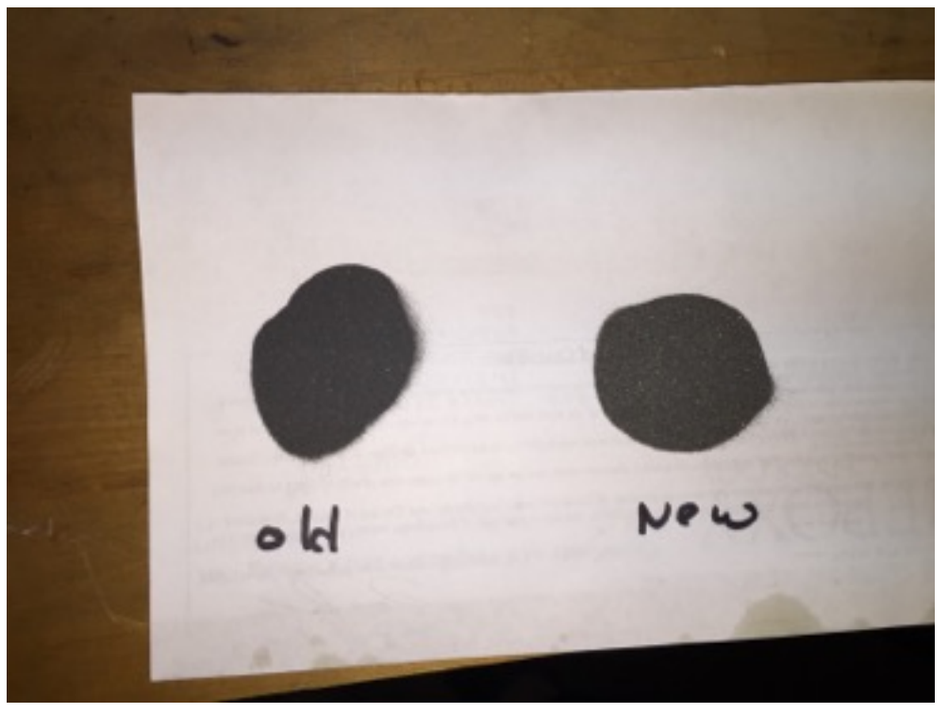
- 25% increase in tower dimension by decreasing segmentation from 0.024x0.024 to 0.03x0.03 from discussions yesterday
- two construction paths to 2D projective:
  - 1x1 blocks: this will work; larger version of the 1x1s already made
  - 2x2 blocks: need to demonstrate that fiber filling and epoxy would work on a block that large
- this summer:
  - determine which process to use for the 1/17 prototype and begin test productions at Illinois

a closer look at the tungsten



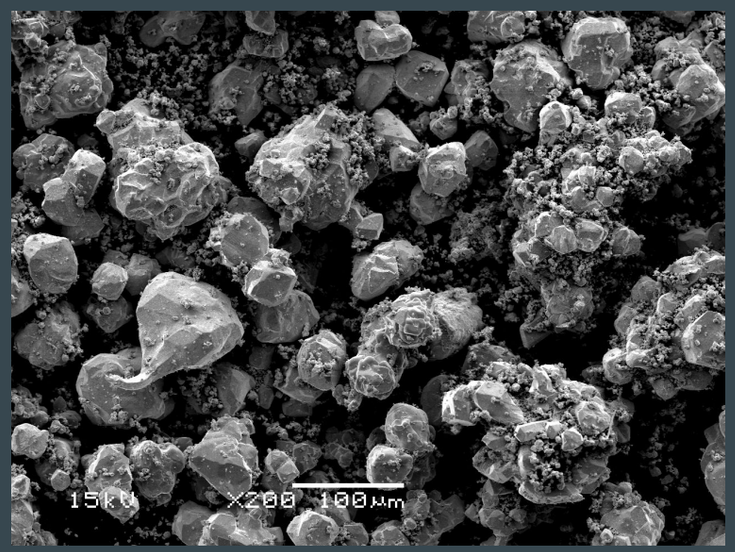
tungsten powder

- begun to investigate and characterize the powder itself
- some obvious batch to batch variation within THP powder samples
- questions:
  - what about powder from other suppliers?
  - what is the tungsten composition of the powder itself?
- used Illinois Materials Research Lab & Microanalysis Lab

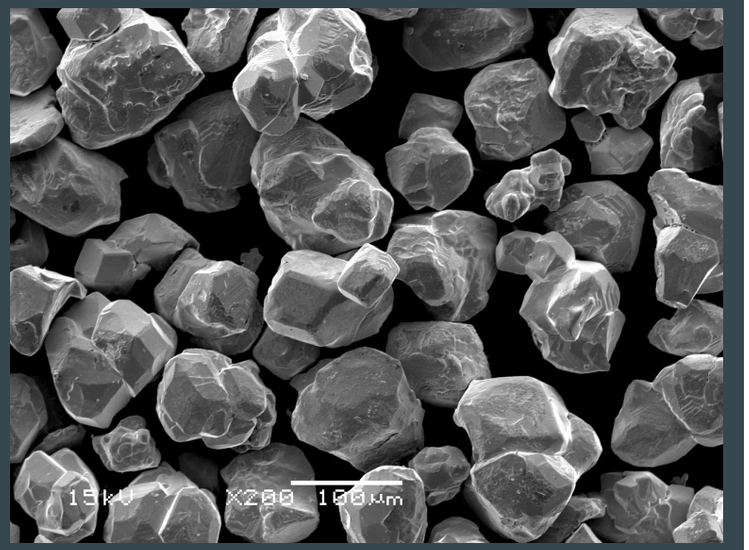


SEM Images (x200)

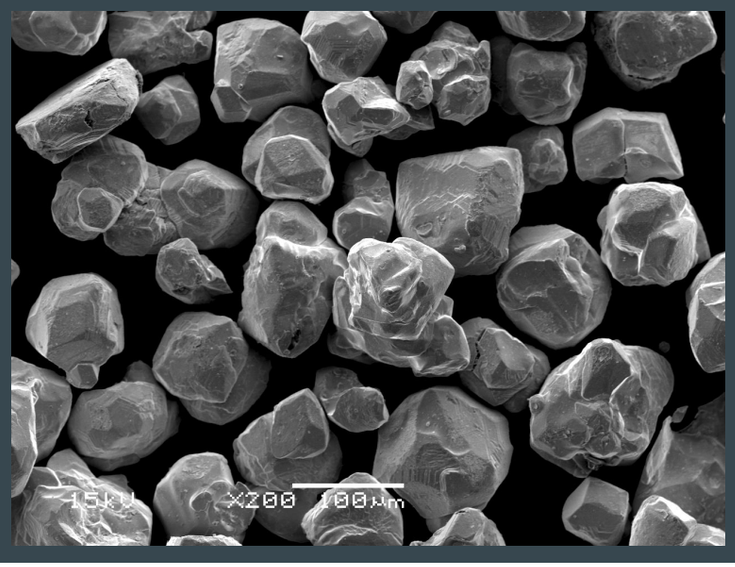
Sample 1 (UIUC)



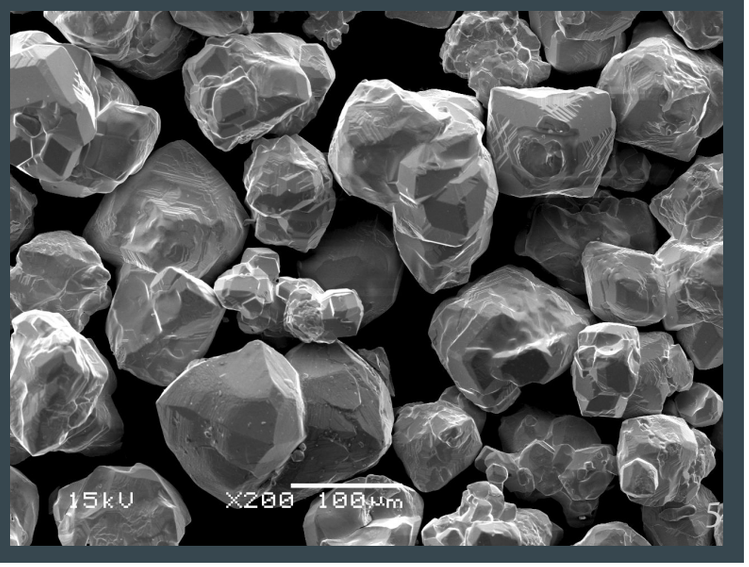
Sample 2 (UIUC)



Sample 3 (UIUC)



Sample 4 (**BNL**)

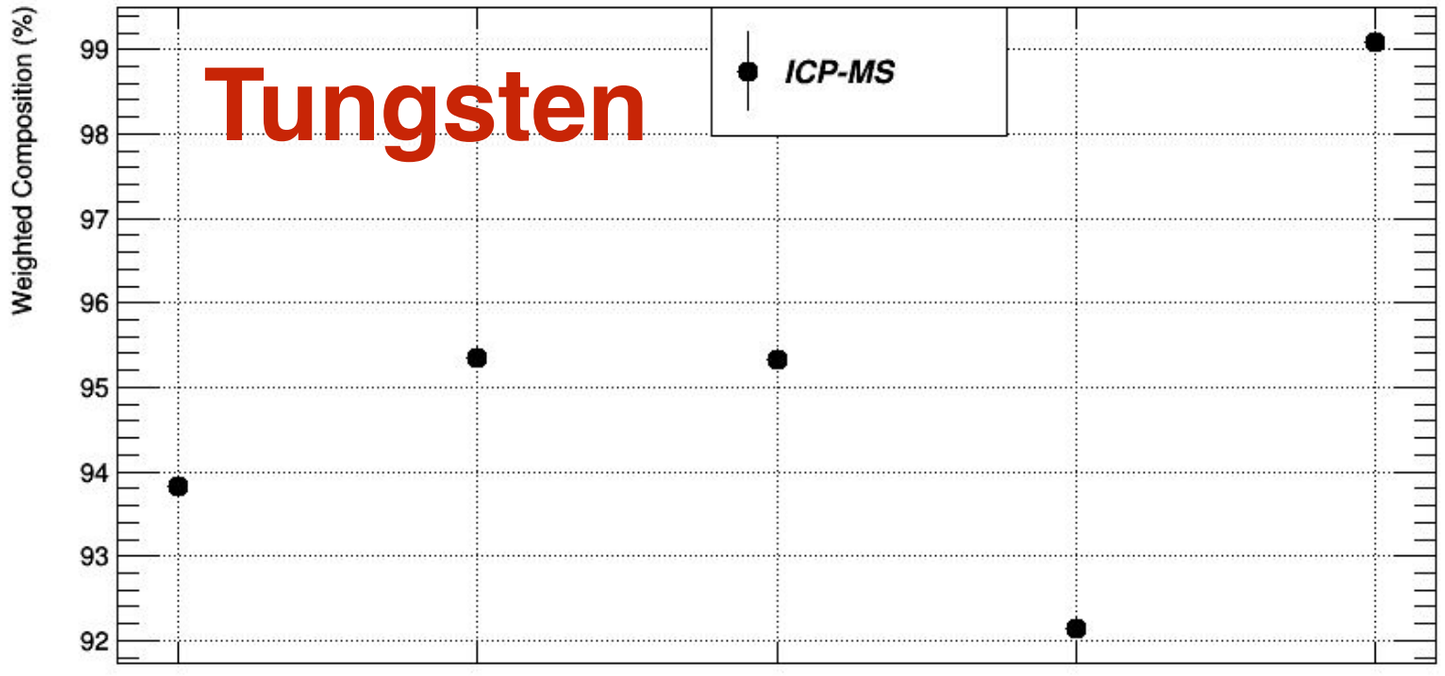


THP Technon 100 powder, four different batches

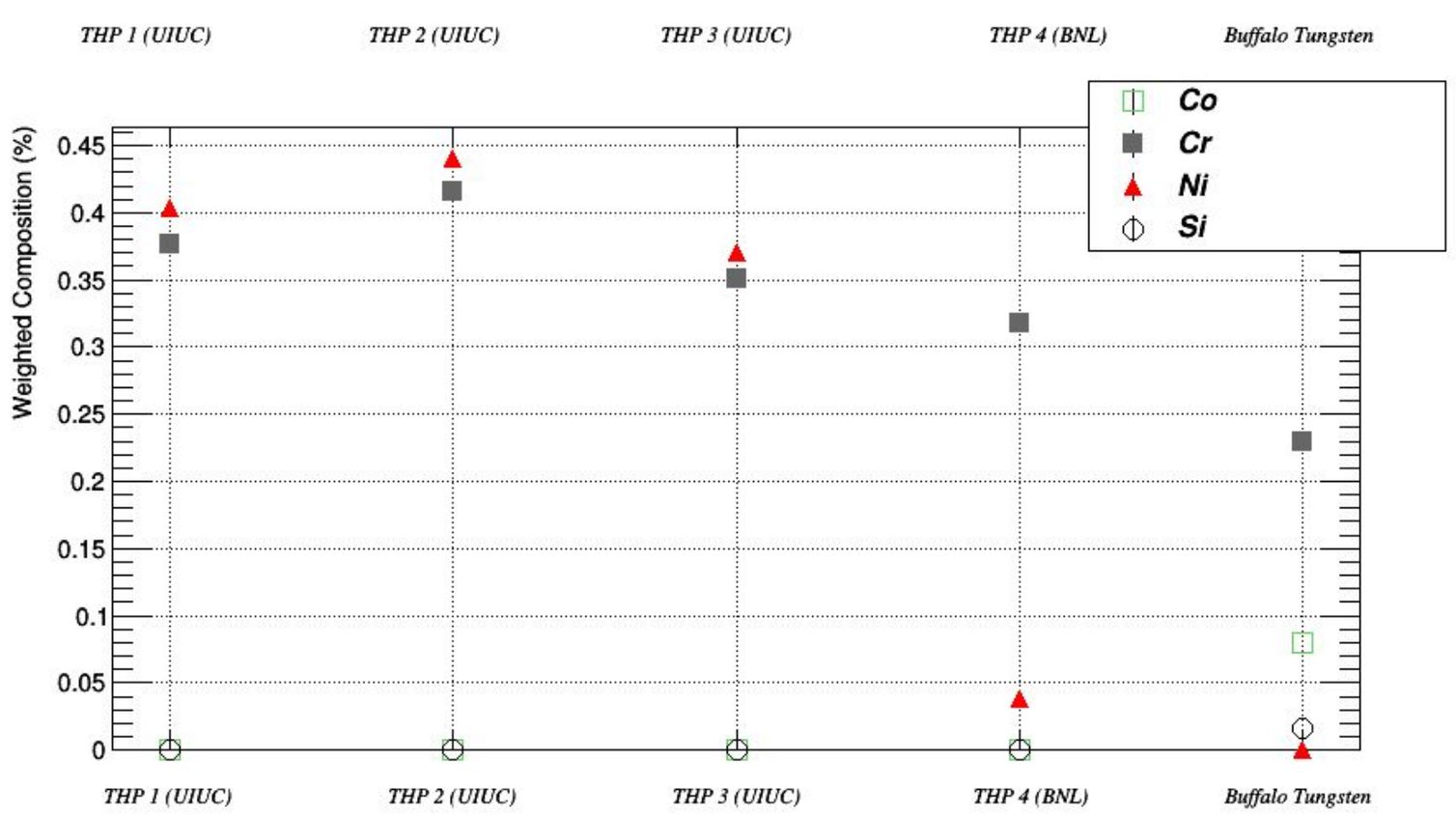
M. Phipps, S. Li

purity of tungsten

THP powder seems ~95% tungsten unclear what the final 5% are



we've ordered powder from several suppliers
want to understand if there is a better source and the specs we need for the final detector



lots to do

- test beam analysis ongoing
- 2D module production toward the 2017 prototype
- determine how best to implement the new EMCal segmentation in the module production process
- construct the 2017 prototype
- simulations of electron, hadron, photon and jet performance

crucial to determining how we will build the final modules!

backups

Absolute MIP Peak